Posture and anatomical adaptations in neonatal flying-foxes (Genus *Pteropus*, suborder Megachiroptera): cautionary tales for carers

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ABSTRACT

Observations on the roosting posture of adult and mother-raised-young flying-foxes demonstrate that there is no good reason for neonate and infant flying-foxes in human care to be tightly wrapped-up with their hind limbs constrained. It is suggested that this practice causes physiological and psychological pain and is likely to impede the animals' normal anatomical, physiological and psychological development, and to compromise their survival in the wild. The role and value of flying fox carer groups are discussed.

Key words: Foster-care, Development.

INTRODUCTION

It is with disquiet that I note the promulgation, in a recent book on the care of captive bats (Barnard 1995), of the fashion — I use the term because the practice in question has no physiological or rational basis — of wrapping foster-reared infant flying-foxes as parcels, with their hind-limbs folded ventrally. Why? Is it that the bats may be flying primates (Pettigrew, Jamieson, Robson, Hall, McNally and Cooper 1989) and need to be nappied like human babies, or does the "packaging" process satisfy some unfulfilled need in the foster carer? Such "packaging" is not compatible with the posture of adults or mother-reared young, as observed in the wild and in our successful captive breeding colonies of *Pteropus poliocephalus, P. alecto* and *P. scapulatus* over the last decade or so (Martin, Kennedy, Little, Luckhoff, O'Brien, Pow, Towers, Waldon and Wang 1995).

THE POSTURE OF ADULT AND INFANT FLYING-FOXES

Consider! The relaxed sleeping posture of an adult flying-fox is hanging from one fully extended hind-limb with claws tendon-locked in position, hooked into a branch or across a wire. I frequently need to handle these bats in captivity: to do so, I wrap the individual animal firmly in soft cloth as it hangs from the cage wire, then unhook its hind-claws from the wire. At this point the animal becomes agitated, struggling to find a grip, then relaxing as it finds my hand and the "security" of "hanging" from it. In most cases, the animal remains relaxed as I carry it head down, only loosely restrained by the cloth, "hanging" from my hand. It will usually remain calm even when I place it in a horizontal position — until I remove my fingers from its hind claws! It then struggles until it finds a grip on the substrate, when it immediately calms.

The pelvis and hind-limbs of a flying-fox are highly specialized and unlike those of humans. For example, the pelvis in female *Pteropus* is "open", in that the bones do not close ventrally to form an "O", though they do in males, and the widely separated pubic bones are joined by an elastic inter-pubic ligament (Martin, unpubl. obs.; Chapman, Hall and Bennett 1994). The hind limbs and claws are extremely versatile and are used in a wide variety of movements additional to those of quadrupedal locomotion — grooming, holding food and precision grasping as the animal lands from flight onto the chosen roost-site. The neonatal flying fox has very well developed fore- and hind-limbs (Fig. 1).

It is well known from other animal species that prolonged constraint of a limb in an abnormal position prevents normal bone growth, muscle development and innervation. Placing the limbs of a neonate flying-fox in a grotesquely abnormal position for any prolonged period during postnatal development is likely to seriously compromise their normal development and function. Packaging and forward-folding of the hind-limbs may also compress the abdomen and thence the diaphragm, with possible long-term effects on gut, heart and lungs. It is also conceivable that specialized vascular control reflexes only develop appropriately in infants maintained with essentially normal posture and movement.

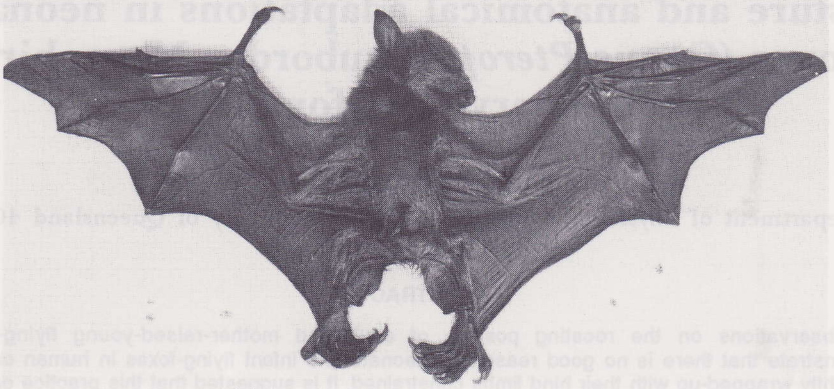
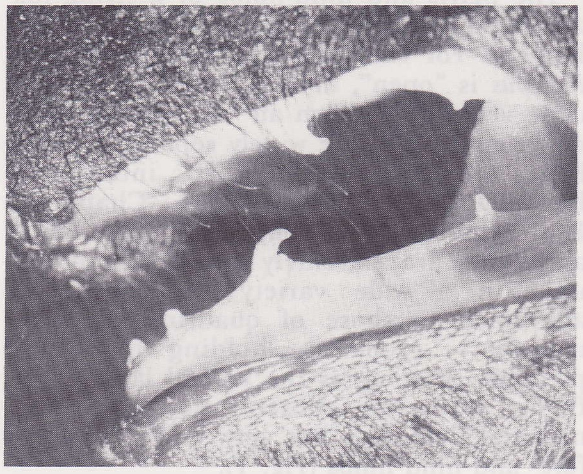
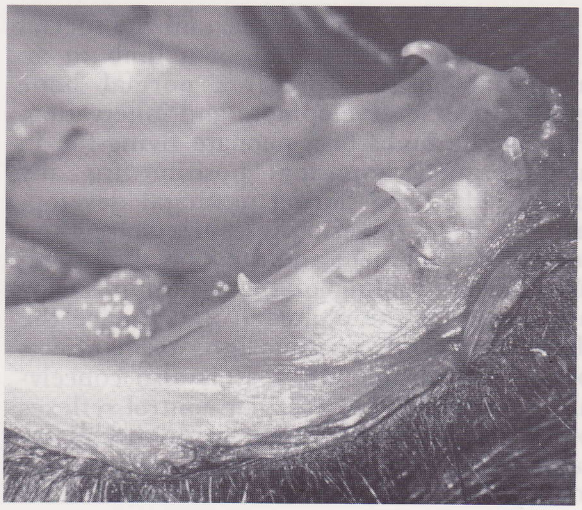


Figure 1. Ventral view of a newborn *P. poliocephalus* showing the well developed fore- and hind-limbs and claws. The remains of the umbilicus protrude from the abdomen.

In removing a live neonate flying-fox from a dead mother it is relatively simple to unhook the infant's hind-limbs from the maternal skin, but the infant then becomes very distressed. It is usually much more difficult to remove the infant from the nipple, and this may necessitate first cutting the nipple from the mother, in order to prize it from between the infant's backwardly curved milk-teeth (Fig. 2). Not surprisingly, as the nipple is removed the infant expresses extreme distress, but this rapidly abates, and the wee-beastie relaxes, when a rubber teat or somesuch is placed in its mouth, its hind-claws are hooked into a cloth, and it is wrapped **loosely** and supported, legs-extended, head-down.

Almost from the instant of its birth the infant flying-fox spends most of its time, enclosed by the maternal wings, hanging head-down across its mother's ventral surface, with hind-limbs fully extended and hind-claws hooked into the mother's skin close to her groin. Neonate flying-foxes have fully-developed, sharp hind-claws, each bearing a minute pad close to the tip (Fig. 3) — presumably an adaptation to prevent the tip piercing the maternal skin too deeply — such pads are absent from juvenile and adult bats.





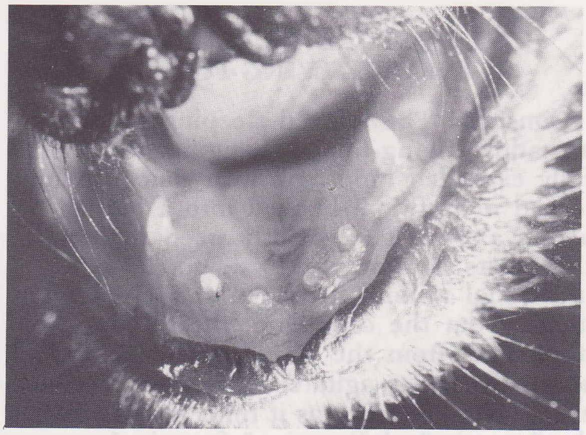


Figure 2. Close-up views of the mouth of the animal in Figure 1, showing the curved milk teeth in the upper and lower jaws.

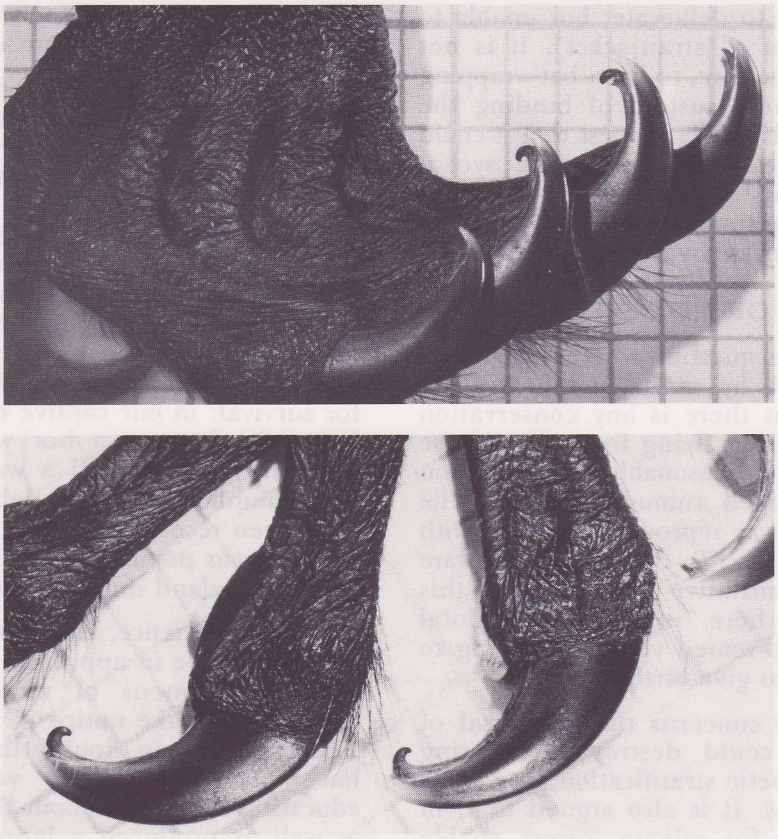


Figure 3. Close-up views of a hindlimb of the animal in Figure 1, showing the claws, each with a small pad close to the sharp tip.

As the relaxed roosting mother hangs head down, hind limbs fully extended, so too does the infant. When the infant suckles, it is also attached to one of the mother's wing-pit nipples, a very firm attachment being effected by the curved milk-teeth. Thus, the suckling infant is extended between these two points of attachment to the mother; this also is the arrangement when the young is carried, for its first few weeks of life, by mother flying out to feed — stretched across mother's belly. The curved teeth and sharp hind-claws are cucial to the neonate's survival.

In the roost, as the suckling infant moves between nipples, it hangs freely, its weight borne on its maternal-skin-embedded hind-claws, and so too when it is not suckling, particularly when it is being manoeuvred and rotated by its mother for maternal cleaning and grooming. With growth, the infant's periods of suckling decrease, it starts exercising its wings — always hanging with legs fully extended and wings flapping; it also starts to express the defaecation-and-urination reversal of posture — whereby it hangs cleanly, head-up by the thumbs. This behaviour develops in the young after a few weeks and is so stereotyped that it is almost certainly an innate "wired-in" reflex rather than a learned behaviour, as some would have it.

Increasingly, the youngster moves away from mother; the first sign in our captives is one infant hind-limb, poking out from mother's enclosing wings, and hooked to the wire between maternal legs. Increasingly the youngster moves out, quadrupedally across the cage roof, but at first sign of threat, it's back to mother, hanging on gently and firmly by hind-claws, within the safe enfolding wings.

TO WRAP OR NOT TO WRAP?

In emphasising the importance of the hind-limbs, I have described only a minute fraction of a sophisticated, specialized, highly-evolved repertoire of anatomical and physiological adaptations and innate (instinctive) behaviours essential for a flying-fox to survive in the wild. Consider therefore, the possible frustration (?), anxiety (?), anguish (?) of an individual animal with strong innate drives to: hang freely, hind-limbs extended; hang, hind-limbs extended and wing-flap; hang, hind-limbs down to defaecate; but unable to do so because of a "straitjacket". It is not unreasonable, therefore, to liken bat-wrapping to the old Chinese custom of binding the feet of young girls, and I suggest that it could cause comparable physiological and psychological pain, and is likely to compromise behavioural and physiological development of the bats and their survival in the wild.

TO CARE OR NOT TO CARE?

Some zoologists question whether neonates should be reared by carers at all, and are unconvinced that there is any conservation benefit from rearing flying foxes for release to the wild. Not unreasonably, they question whether hand-reared animals survive in the wild or integrate as reproducing adults with the wild population. To date, I am unaware of any firm quantitative data to settle this issue, though there is much anecdotal evidence of hand-reared young returning to carers as adults to give birth.

There are also concerns that dispersal of bats by carers could destroy pre-existing geographical genetic stratification, as well as spread pathogens. It is also argued that, in rearing orphans for release, carers enable genetically unfit individuals to survive, and so undermine the genetic fitness and long-term viability of the species. I argue that most young currently coming into care are not orphaned by virtue of genetic inferiority, but by the massive environmental degradation and modification caused by human-kind (e.g., suburban electricity cables). The counter argument is that, if a species is to adapt and survive in such recently degraded environments, natural selection by differential mortality must be allowed to take its course uncompromised.

One critic maintains that many carers "adhere to quite bizarre practices even in the face of scientific evidence to the contrary" and, not unreasonably, calls for guidelines for carers. Indeed, I have met carers who did not supply captive flying-foxes with water because "they don't drink"! The basis for the practice was the idea that the bats got all that they needed from fruit. There was also an element of maternal "don't drink before you eat, dear, it will spoil your appetite".

Mammals have specific centres in the brain which deal with appetite for food and when to stop eating, and other quite separate centres which regulate water balance and thirst. To my knowledge, no specific research has been done on such centres in flying-foxes, but there is no reason to suppose that they differ from other mammals in this regard. In the wild, flying-foxes will lap water on the wing, or dowse their breasts in water and lick it from their fur. Water is essential for survival: in our captive colonies, we once lost animals over a hot weekend because someone failed to fill a water bucket, and huge numbers of heat/ dehydration deaths have been recorded [by carer groups] among wild *Pteropus* populations in New South Wales and Queensland during heat waves.

In my experience, most major carer groups are responsible in approach, publish detailed sensible regimens of care and codes of practice and take notice of scientific advice. There is also no doubt that carers groups have played a major, valuable role in educating the public about flying fox biology, as well as produced a large body of scientifically invaluable data on behaviour, growth-rate, breeding season, captive breeding and so forth. Their contributions are not only relevant to Australian species, but to the many endangered species of *Pteropus* overseas.

Recently, the flying fox carer-network played a key role in public health by enabling the detection and monitoring of flying-fox paramyxovirus and flying fox and micro-bat *Lyssa* (rabies) virus. The importance of carer groups in the public health issue of animal-born diseases cannot be over-emphasized. Carers can supply a broad range of native species for study, which public-health authorities could not otherwise easily access, and carers can usually recognize if an animal is behaving abnormally. By collecting sick, injured and possibly dangerous animals, carers provide essential frontline protection to the public. Overall, I support the continuing activity of the carer groups.

CAPTIONS FOR COLOUR PICTURES OPPOSITE.
Photographs courtesy of Nancy Pallin of the Ku-ring-gai Bat Colony Committee Inc.

Top left: Female and young — could win mother/baby contest. Photograph by Derek Morton.

Top right: Female suckling young. Photograph by Derek Morton.

Middle left: Infant holding onto mother with thumbs, legs extended lower than his body to urinate/defaecate. Photograph by David Williams.

Middle right: Orphaned juvenile clutching large piece of apple with hind claw during feeding. Photograph by Derek Morton.

Bottom: Female with infant feeding from right nipple, foot holding near her groin. Photograph by David Williams.

Nevertheless, irrespective of whether animals are kept for laboratory study or release to the wild, we should, when caring for them, attempt to meet their *evolved needs*, rather than imposing some arbitrary, human-misconceived pattern. For this, it is essential that there is accurate knowledge of the normal processes.

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BOOK REVIEWS — BOOK REVIEWS

Threatened Frogs of New South Wales: Habitats, Status and Conservation. Edited by H. Ehmann, 1997.
Australian Heritage Commission and NSW Department of Urban Affairs and Planning.
ISBN 0-646-31970.

The dedicated team of contributors from the Frog and Tadpole Study Group of NSW Inc (FATS Group of NSW) have contributed a wealth of knowledge, gained over many years, to provide an excellent database on the threatened frog fauna of New South Wales. The work will undoubtedly provide further impetus for the study and observation of this ecologically important group, at a time of unprecedented decline in frog numbers from both apparently pristine and disturbed habitats. On each of the 25 threatened species of New South Wales there is a synopsis of the known information (much of it previously unpublished), including a distribution map, description of former and current distribution of each species, details of each species' habitat, factors considered to be contributing to their decline and associated threats, together with a list of the conservation reserves in which each species is currently extant. The care taken to document details of each species separately provides easy access to information on a particular frog and therefore provides an excellent reference source. However it is recommended that unless the reader is a particularly dedicated "frogologist", there be no attempt made to systematically read the book from cover to cover. The senses will almost certainly become dulled by the repetitiveness imposed by the approach to species' documentation. Reading the information on several species in the same format provides the best cure for insomnia that I have found in quite some time. Although as a reference text the book is invaluable, I urge the authors to also consider providing this important information in a form more digestible to the popular press to encourage a wider segment of the community to realize the importance and vulnerability of these wonderful animals.

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